We thank the **reviewer#2** for the useful suggestions to improve the paper. These comments are all valuable and very helpful for revising and improving our manuscript, as well as the important guiding significance to our researches. These changes in the revise manuscript have been **marked red** in the track changes version manuscript, as well as the point to point responses have listed as following:

General comments:

The mesosphere and lower thermosphere (MLT) is the boundary between the middle atmosphere and the upper atmosphere. Physical processes in the MLT determine the fluxes of waves and tides that propagate into the thermosphere and so act to influence the coupling of these atmospheric regions. There is thus a need for measurements able to characterise the properties of the MLT. Measurements of winds and temperatures in the MLT have been made for many years by radars, lidars and satellites. However, it is very difficult to measure densities at these heights and such measurements are particularly valuable.

This paper presents observations of MLT densities made by combining radar measurements of ambipolar diffusion coefficient with satellite measurements of temperature. A total of nine radars are used, giving coverage over all latitudinal regimes apart from mid-latitudes in the SH. The key results of the paper are determinations of the seasonal cycle in MLT density over the different radars, which also reveals interesting inter-hemispheric differences and suggestions of MLT perturbations associated with the MJO. Comparisons are made with models which highlight deficiencies in the models.

The paper is exceptionally well written and was a pleasure to read. The analysis is persuasive and is presented in a logical manner. The figures are appropriate, easy to understand and nicely produced. The references are adequate and up to date. The abstract is clear and accessible. Overall, this is scientific work of a high standard which presents interesting and significant results.

Response: Thank you for your great comments. This will encourage us to improve our manuscript, as well as the important guiding significance to our researches.

Minor comment:

1. The authors determine ambipolar diffusion coefficient at each height from the radar data. Is there any sorting of data by elevation angle? Meteors recorded at low elevation angle will be at long ranges and so even a small error in elevation angle may thus correspond to a significant error in height. Conversely, errors in elevation angle will produce smaller errors in height near the zenith. The authors should explain if they used any sorting and comment on this possibility.

Response: Thank you for pointing this out. We apologize that we forgot to refer to data processing in this study. In the data processing, we actually did the zenith selection for the meteor echoes. The data processing is followed by Yi et al. (2017, 2018a). In order to avoid the possibility of excessive error in the height estimates of individual meteors, trail detections for this study were restricted to zenith angles of less than 60°.

We have added this in the revised manuscript. In order to avoid the possibility of excessive error in the height estimates of individual meteors, trail detections for this study were restricted to zenith angles of less than 60°.

2. The authors use MLS temperatures in combination with the ambipolar diffusion to estimate density. However, at these heights the vertical resolution of MLS is poor, e.g., at z = 81 km the vertical resolution is _ 14 km. Given that the atmosphere at these height can have sharp temperature gradients associated with the mesopause, how does this impact the analysis? Is this not a major source of uncertainty in the determination of density given that the actual atmospheric temperature at a particular height may be rather different from the one derived from MLS measurements of low resolution?

Response: Thank you for pointing this out. First, we should point out that we chose the MLS temperature measurements because the Aura/MLS has very good temporal continuity in polar region. Schwartz et al. (2008) suggested that the vertical resolution of geopotential height (GPH) is ~13 km at 0.001 hPa, however, the precision is ±100 m, and the observed bias is -450 m. In addition, in the response, we also compared the geopotential heights from the MLS and SABER measurements. Figure R1 shows the daily geometric heights at pressure level 0.00464 (red), 0.00215 (green), 0.001 (blue) and 0.000464 (black) hPa calculated from the MLS geopotential heights compare to the geometric heights estimated from SABER pressure measurements over Beijing. The Geometric heights, z for Aura MLS observations were computed from geopotential heights, z_g via the equation $z = z_g R_e(\emptyset)[R_e(\emptyset) - z_g]^{-1}$, where $R_e(\emptyset)$is the radius of Earth at latitude ϕ, based on the WGS84 ellipsoid [*Decker*, 1986]. As shown in Figure R1, the seasonal variations of the geometric height at each pressure level from the MLS and SABER measurements are consistent. The biases between two geometric heights are less than 1km at pressure level 0.00464, 0.00215, 0.001 hPa and are about 2 km at pressure level 0.000464 hPa. So these results confirm that the geopotential height is precise enough and should not introduce major uncertainty in temperature interpolation.

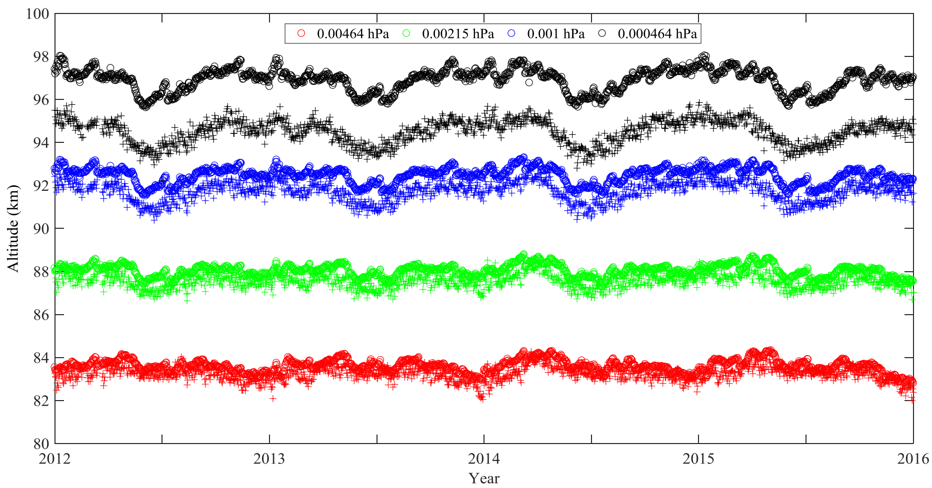

Figure R1. Comparison of the geometric heights at pressure level 0.00464 (red), 0.00215 (green), 0.001 (blue) and 0.000464 (black) hPa from Aura/MLS (plus sign) and TIMED/SABER (circle sign) measurements from 2012 to 2016.

TECHNICAL CORRECTIONS

1. Please check all references are present – e.g., Dowdy et al. (2001) is mentioned on p3 but missing from the references.

Response: Thank you for pointing this out. We have added the missing reference (i.e., Dowdy et al. 2001) in the revised manuscript.

Reference: Dowdy, A., Vincent, R., Igarashi, K., Murayama, Y., and Murphy, D.: A comparison of mean winds and gravity wave activity in the northern and southern polar MLT. Geophys Res Lett, 28, 1475-1478, 2001.

2. The manuscript refers to “densities”, but the measurements are actually “relative densities”. This should be corrected throughout to avoid confusion.

Response: Thank you for pointing this out, we have corrected throughout in the revised manuscript.

References in this response:

Decker, B.: World Geodetic System 1984, Def. Mapp. Agency Aerosp. Cent., St. Louis AFS, Mo, 1986.

Schwartz, M., Lambert, A., Manney, G., Read, W., and Livesey, N.: Validation of the Aura Microwave Limb Sounder temperature and geopotential height measurements, J. Geophys. Res., 113, D15S11, doi:10.1029/2007JD008783, 2008.

Yi W., Reid, I., Xue, X., Younger, J., Murphy, D., Chen, T., and Dou, X.:, Response of neutral mesospheric density to geomagnetic forcing, Geophys. Res. Lett., doi: 10.1002/2017GL074813, 2017.

Yi, W., Reid, I., Xue, X., Murphy, D., Hall, C., Tsutsumi, M., Ning, B., Li, G., Younger, J., Chen, T., and Dou, X.: High- and middle-latitude neutral mesospheric density response to geomagnetic storms. Geophysical Research Letters, 45, 436–444. https://doi.org/10.1002/2017GL076282, 2018a.